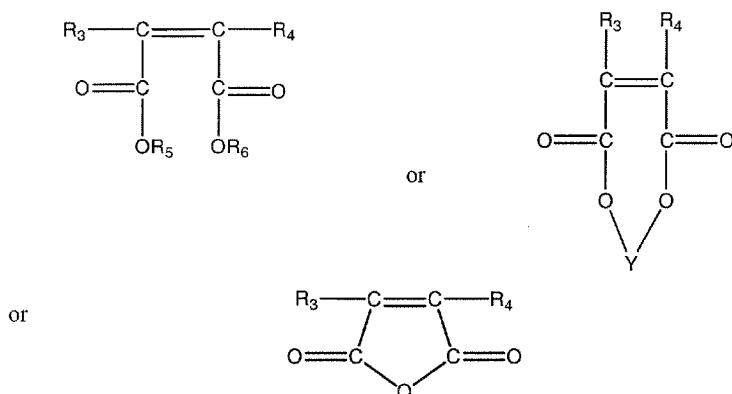
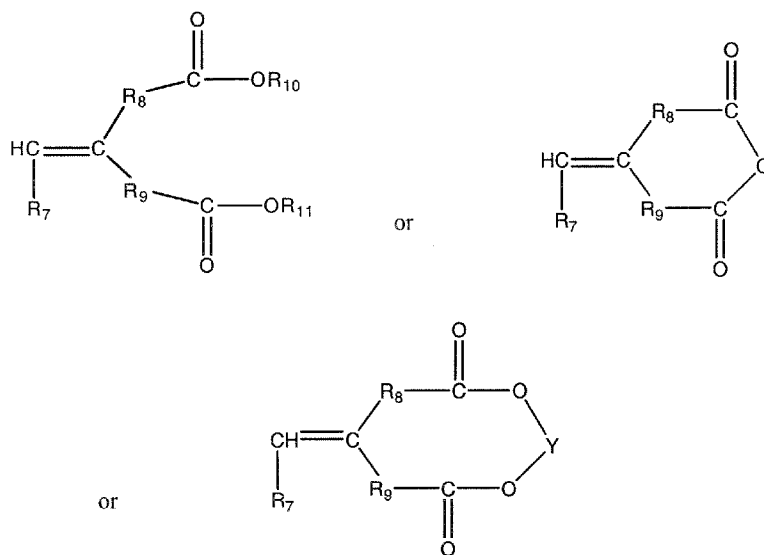


Claims

- [c1] 1.A method of forming a combination fertilizer product and polymer comprising the step of:
combining a substantially water soluble dicarboxylic polymer and a fertilizer product, said polymer being at least partially ethylenically unsaturated.
- [c2] 2.The method of claim 1, said polymer being formed by the steps of:
providing a reaction mixture comprising at least two different reactants selected from the group consisting of first and second or a mixture of said second reactants, wherein said first reactant is a dicarboxylic reactant of the general formula



and said second reactant is a dicarboxylic reactant of the general formula



wherein each R_7 is individually and respectively selected from the group consisting of H, OH, C_1 - C_{30} straight, branched chain and cyclic alkyl or aryl groups, C_1 - C_{30} straight, branched chain and cyclic alkyl or aryl based ester groups, $R'CO_2$ groups, OR' groups and $COOX$ groups, wherein R' is selected from the group consisting of C_1 - C_{30} straight, branched chain and cyclic alkyl or aryl groups and X is selected from the group consisting of H, the alkali metals, NH_4 and the C_1 - C_4 alkyl ammonium groups, R_3 and R_4 are individually and respectively selected from the group consisting of H, C_1 - C_{30} straight, branched chain and cyclic alkyl or aryl groups, R_5 , R_6 , R_{10} and R_{11} are individually and respectively selected from the group consisting of H, the alkali metals, NH_4 and the C_1 - C_4 alkyl ammonium groups, Y is selected from the group consisting of Fe, Mn, Mg, Zn, Cu, Ni, Co, Mo, V and Ca, and R_8 and R_9 are individually and respectively

selected from the group consisting of nothing (i.e., the groups are non-existent), CH_2 , C_2H_4 , and C_3H_6 , each of said moieties having or being modified to have a total of two COO groups therein; and polymerizing said reaction mixture to form a polymer having polymeric subunits therein with carboxyl-containing groups.

[c3] 3.The method of claim 2, said first reactant being maleic anhydride and said second reactant being itaconic acid.

[c4] 4.The method of claim 2, said polymerization step being carried out by generating free radicals in said reaction mixture.

[c5] 5.The method of claim 4, said free radical generation step comprising the step of adding a peroxide to said reaction mixture.

[c6] 6.The method of claim 4, said free radical generation step comprising the step of subjecting said reaction mixture to UV light.

[c7] 7.The method of claim 4, said free radical generation step comprising the step of adding a persulfate to said reaction mixture.

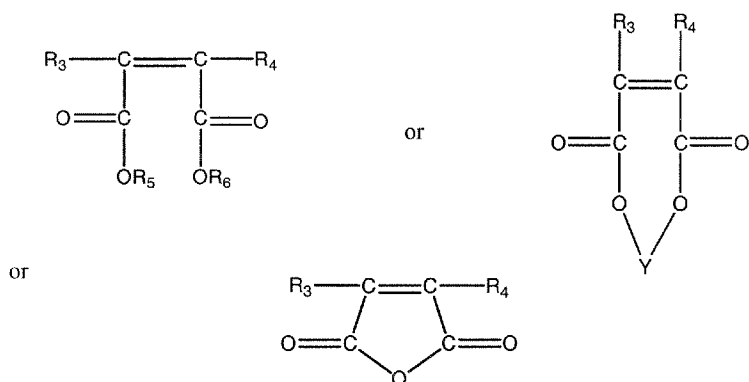
[c8] 8.The method of claim 2, said reaction mixture being formed in a solvent selected from the group consisting

of water and acetone.

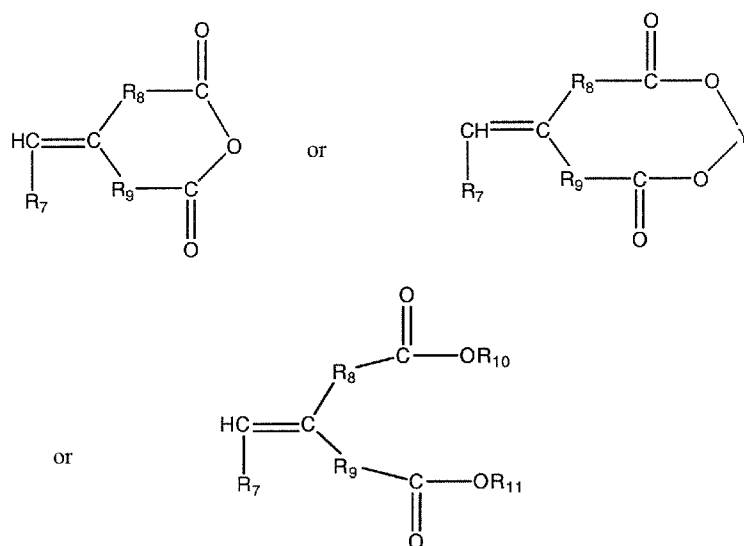
- [c9] 9.The method of claim 2, said polymerization step being carried out at a temperature of from about 0EC to about 120EC for a period of from about 0.25 hours to about 24. hours.
- [c10] 10.The method of claim 2, said polymerization step being carried out under an inert gas atmosphere.
- [c11] 11.The method of claim 2, including the step of drying said polymer to a solid form.
- [c12] 12.The method of claim 2, including the step of reacting said polymer with an ion to form a complex with the polymer.
- [c13] 13.The method of claim 12, said ion being selected from the group consisting of Fe, Zn, Cu, Mn, Mg, Co, Ni, Al, V or Ca ion.
- [c14] 14.The method of claim 2, said combining step occurring by a method selected from the group consisting of applying said polymer to the surface of a fertilizer particle, co-grinding said fertilizer with said polymer, co-dispersing said polymer and said fertilizer in an aqueous medium, thoroughly mixing said polymer with said fertilizer, and mixtures thereof.

- [c15] 15.The method of claim 1, said polymer substantially coating said fertilizer product.
- [c16] 16.The method of claim 2, including the step of reacting at least one of said reactants with an ion to form a complex.
- [c17] 17.The method of claim 16, said ion being selected from the group consisting of Fe, Zn, Cu, Mn, Mg, Co, Ni, Al, V or Ca ion.
- [c18] 18.The method of claim 1, said fertilizer product being selected from the group consisting of phosphate-based fertilizers, organic wastes, waste waters, fertilizers containing nitrogen, phosphorous, potassium calcium, magnesium, sulfur, boron, or molybdenum materials, fertilizers containing micronutrients, and oxides, sulfates, chlorides, and chelates of such micronutrients.
- [c19] 19.A method of forming a combination fertilizer product and polymer comprising the step of:
combining a substantially water soluble dicarboxylic polymer and a fertilizer product, said polymer being at least partially ethylenically unsaturated and being formed by the steps of:
providing a reaction mixture comprising at least two different reactants selected from the group consisting of

first and second or a mixture of said second reactants,
wherein said first reactant is a dicarboxylic reactant of
the general formula



and said second reactant is a dicarboxylic reactant of the
general formula



wherein each R_7 is individually and respectively selected
from the group consisting of H, OH, C_1-C_{30} straight,
branched chain and cyclic alkyl or aryl groups, C_1-C_{30}
straight, branched chain and cyclic alkyl or aryl based
ester groups, $\text{R}'\text{CO}_2$ groups, OR' groups and COOX
groups, wherein R' is selected from the group consisting

of C_1-C_{30} straight, branched chain and cyclic alkyl or aryl groups and X is selected from the group consisting of H, the alkali metals, NH_4 and the C_1-C_4 alkyl ammonium groups, R_3 and R_4 are individually and respectively selected from the group consisting of H, C_1-C_{30} straight, branched chain and cyclic alkyl or aryl groups, R_5 , R_6 , R_{10} and R_{11} are individually and respectively selected from the group consisting of H, the alkali metals, NH_4 and the C_1-C_4 alkyl ammonium groups, Y is selected from the group consisting of Fe, Mn, Mg, Zn, Cu, Ni, Co, Mo, V and Ca, and R_8 and R_9 are individually and respectively selected from the group consisting of nothing (i.e., the groups are non-existent), CH_2 , C_2H_4 , and C_3H_6 , each of said moieties having or being modified to have a total of two COO groups therein; and polymerizing said reaction mixture to form a polymer having polymeric subunits therein with carbonyl-containing groups.

- [c20] 20.The method of claim 19, said first reactant being maleic anhydride and said second reactant being itaconic acid.
- [c21] 21.The method of claim 19, said polymerization step being carried out by generating free radicals in said reaction mixture.
- [c22] 22.The method of claim 21, said free radical generation

step comprising the step of adding a peroxide to said reaction mixture.

[c23] 23.The method of claim 21, said free radical generation step comprising the step of subjecting said reaction mixture to UV light.

[c24] 24.The method of claim 21, said free radical generation step comprising the step of adding a persulfate to said reaction mixture.

[c25] 25.The method of claim 19, said reaction mixture being formed in a solvent selected from the group consisting of water and acetone.

[c26] 26.The method of claim 19, said polymerization step being carried out at a temperature of from about 0EC to about 120EC for a period of from about 0.25 hours to about 24. hours.

[c27] 27.The method of claim 19, said polymerization step being carried out under an inert gas atmosphere.

[c28] 28.The method of claim 19, including the step of drying said polymer to a solid form.

[c29] 29.The method of claim 19, including the step of reacting said polymer with an ion to form a complex with the polymer.

- [c30] 30. The method of claim 29, said ion being selected from the group consisting of Fe, Zn, Cu, Mn, Mg, Co, Ni, Al, V or Ca ion.
- [c31] 31. The method of claim 19, said combining step occurring by a method selected from the group consisting of applying said polymer to the surface of a fertilizer particle, co-grinding said fertilizer with said polymer, co-dispersing said polymer and said fertilizer in an aqueous medium, thoroughly mixing said polymer with said fertilizer, and mixtures thereof.
- [c32] 32. The method of claim 19, said polymer substantially coating said fertilizer product.
- [c33] 33. The method of claim 19, including the step of reacting at least one of said reactants with an ion to form a complex.
- [c34] 34. The method of claim 33, said ion being selected from the group consisting of Fe, Zn, Cu, Mn, Mg, Co, Ni, Al, V or Ca ion.